

# Benchmark for Reactive Multiphase Flow in Porous Media Full results

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# 1 Test 1.1: 1D kinetic chemistry

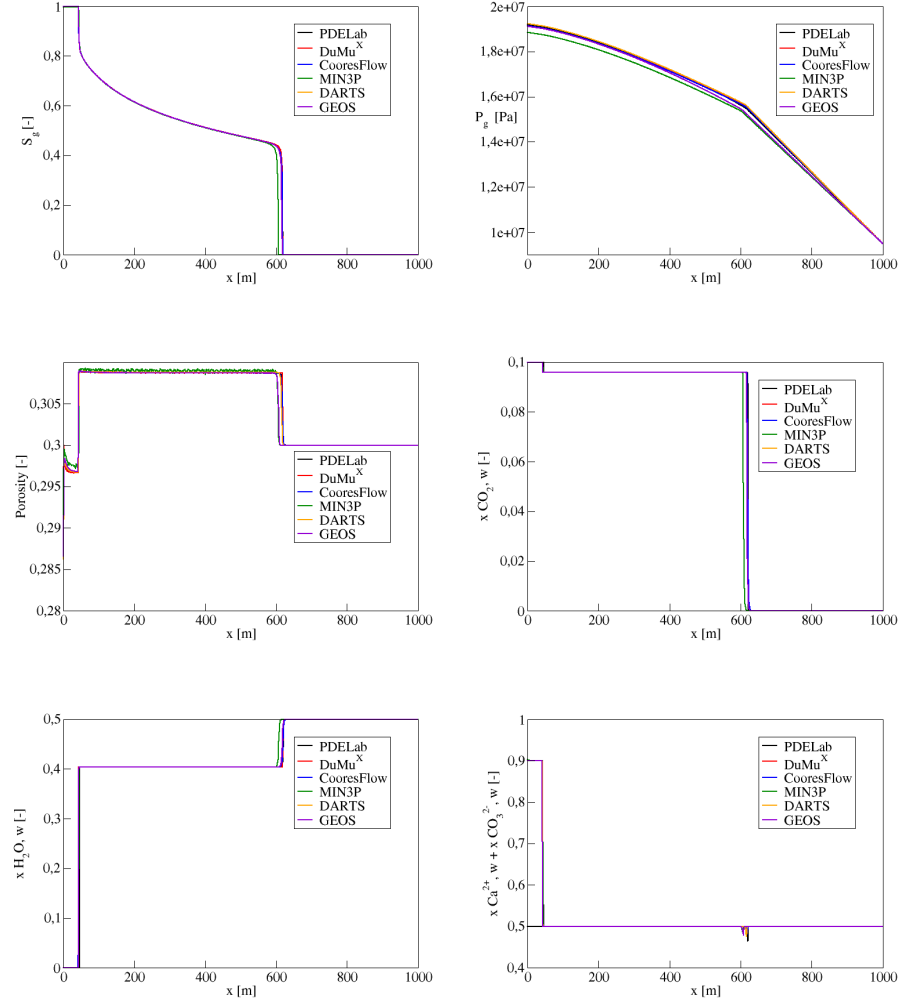


Figure 1: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $CO_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $t = 1000$  days for Test 1.1.

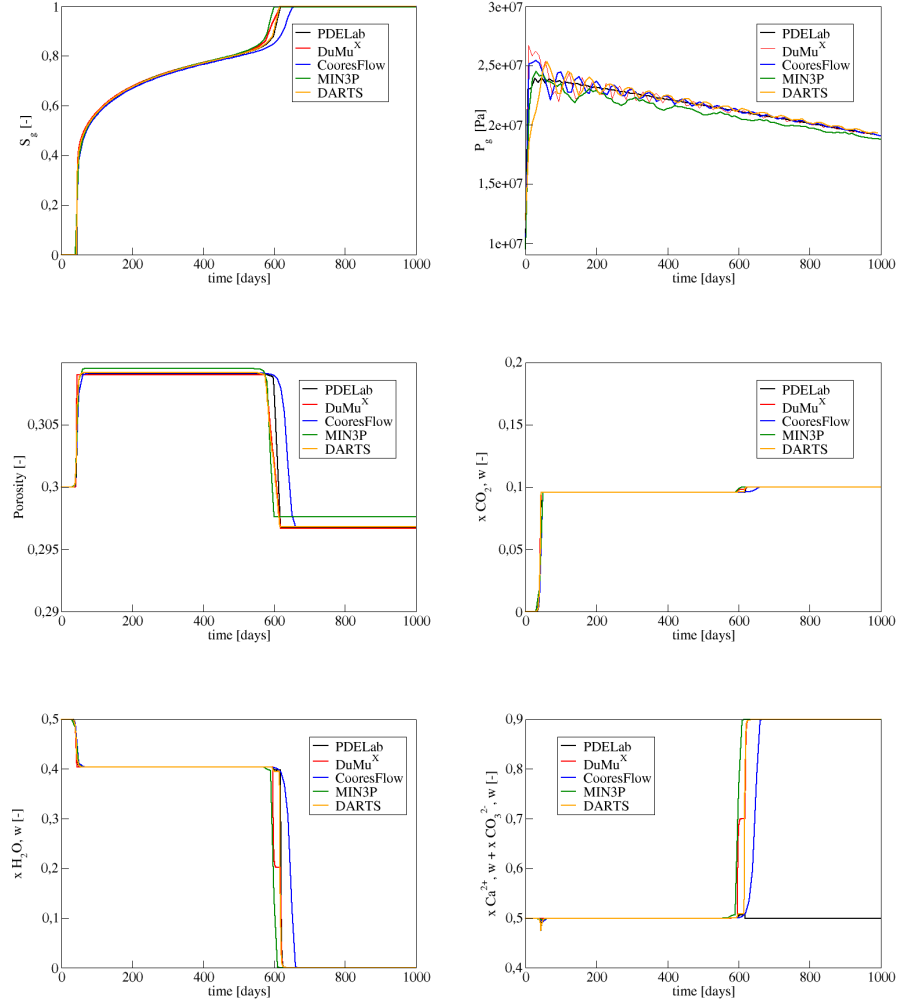


Figure 2: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $CO_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $x = 25$  m for Test 1.1.

## 2 Test 1.2: 1D equilibrium chemistry

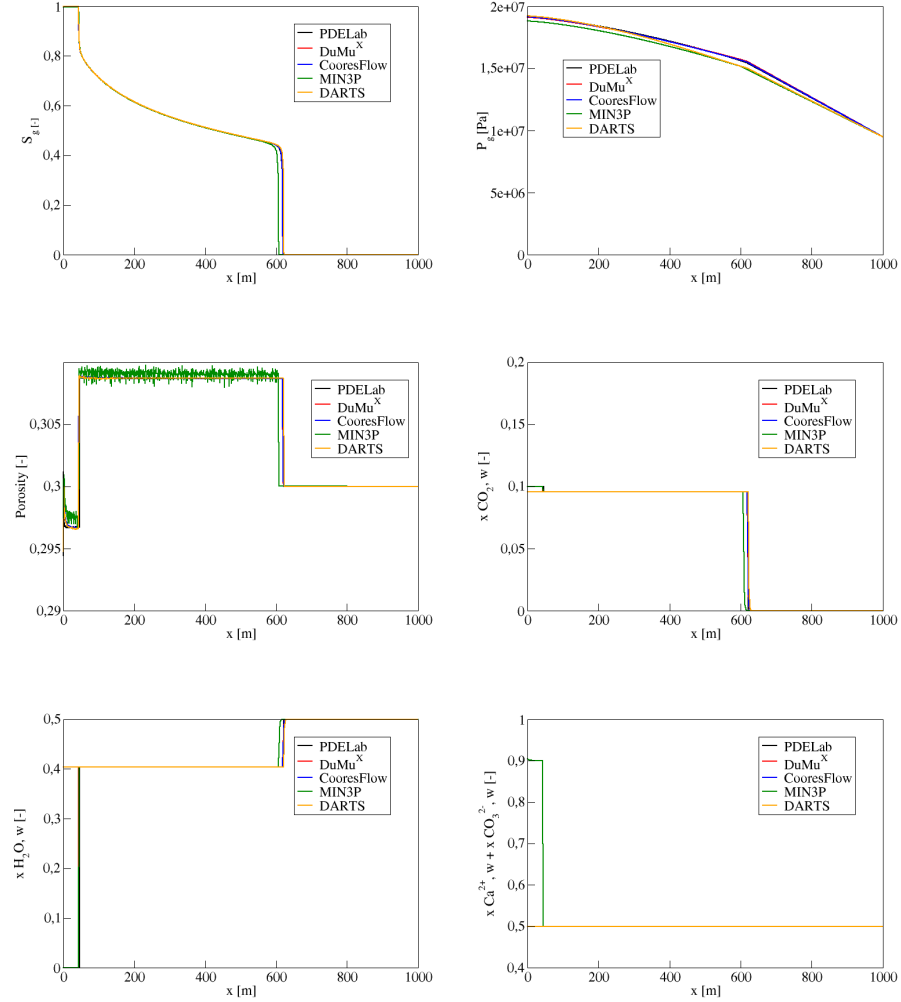


Figure 3: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $\text{CO}_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $t = 1000$  days for Test 1.2.

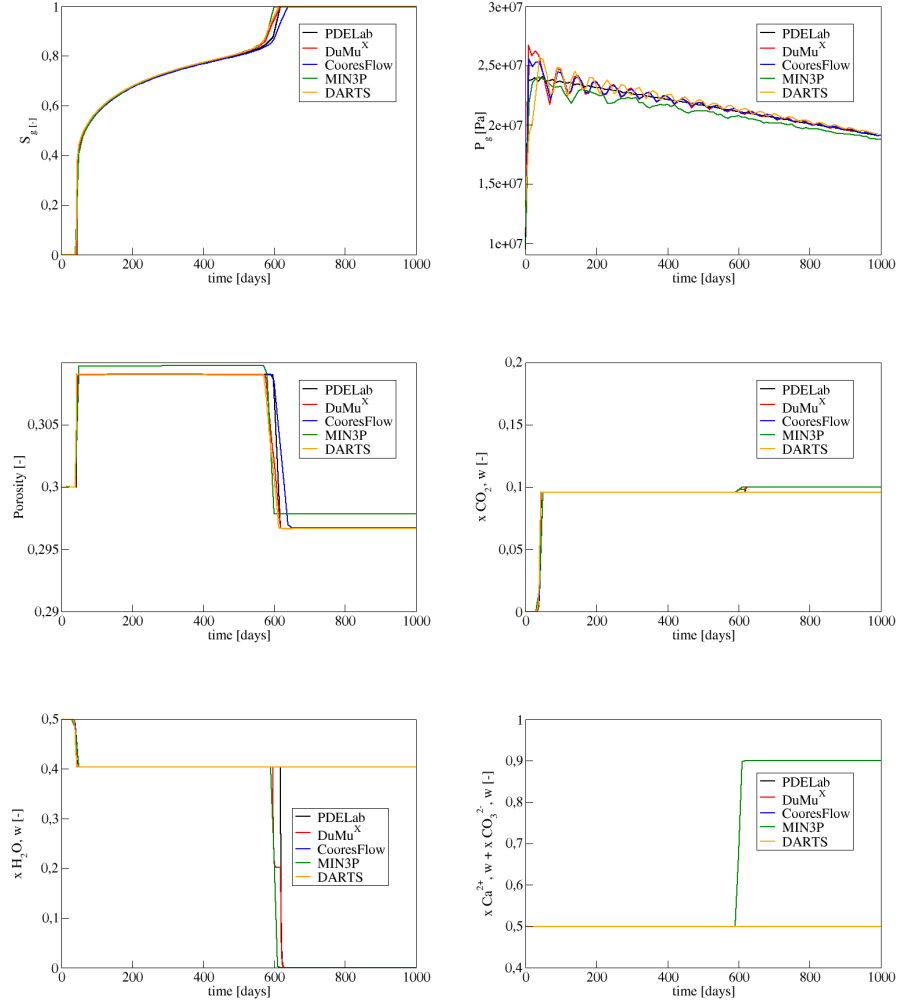


Figure 4: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $CO_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $x = 25$  m for Test 1.2.

### 3 Test 2.1: 2D without gravity

#### 3.1 Contour maps for the Test 2.1 without gravity

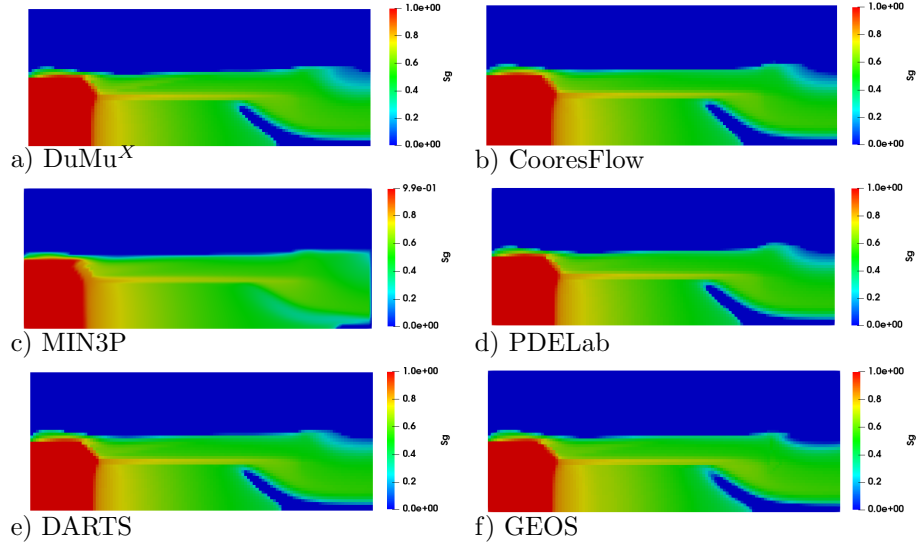


Figure 5: Comparison of gas saturation  $S_g$  at  $t = 1000$  days for Test 2.1 without gravity.

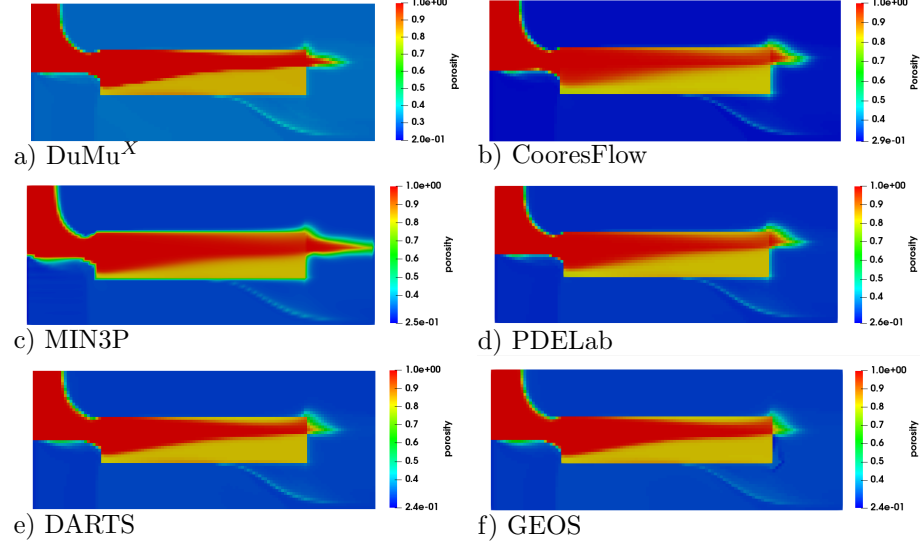


Figure 6: Comparison of porosity  $\phi$  at  $t = 1000$  days for Test 2.1 without gravity.

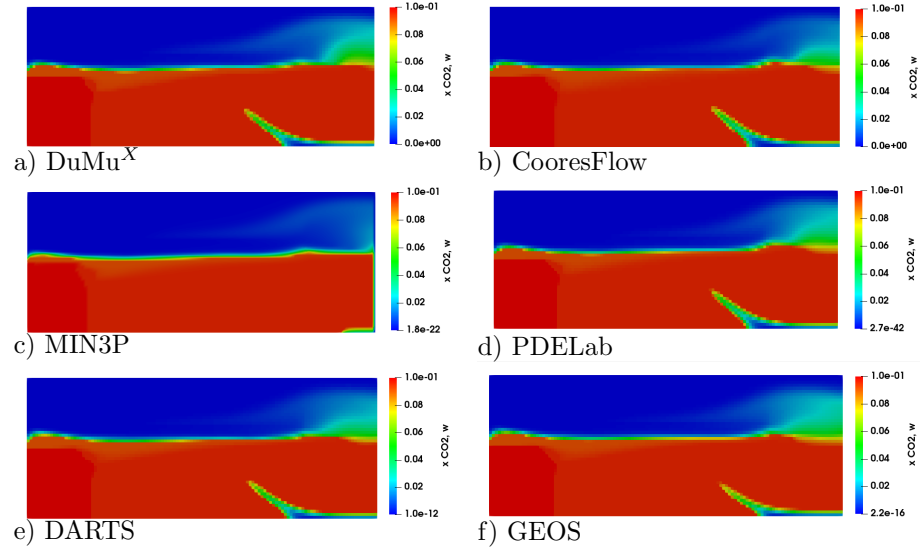


Figure 7: Comparison of liquid  $\text{CO}_2$  fraction  $x_{\text{CO}_2, w}$  at  $t = 1000$  days for Test 2.1 without gravity.

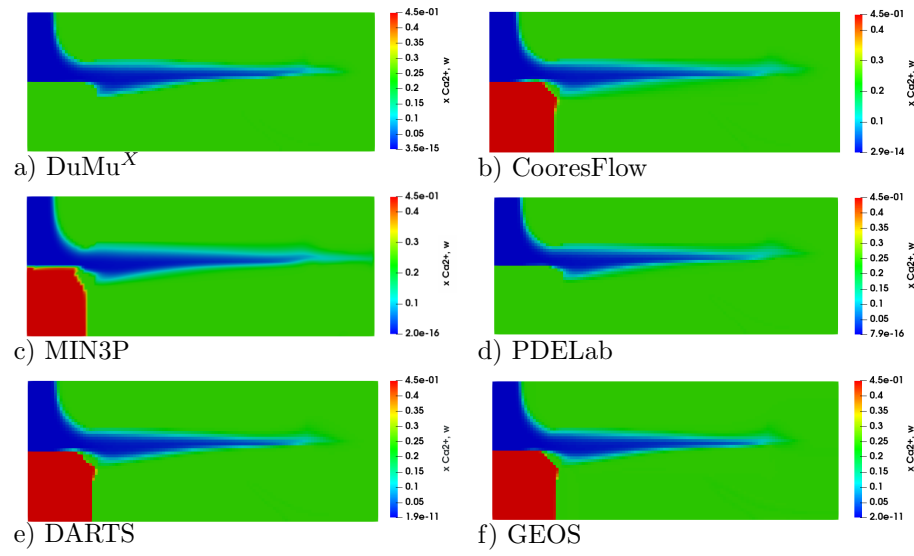


Figure 8: Comparison of liquid  $\text{Ca}^{2+}$  fraction  $x_{\text{Ca}^{2+},w}$  at  $t = 1000$  days for Test 2.1 without gravity.



### 3.2 Vertical line at $x = 40$ m for the Test 2.1 without gravity

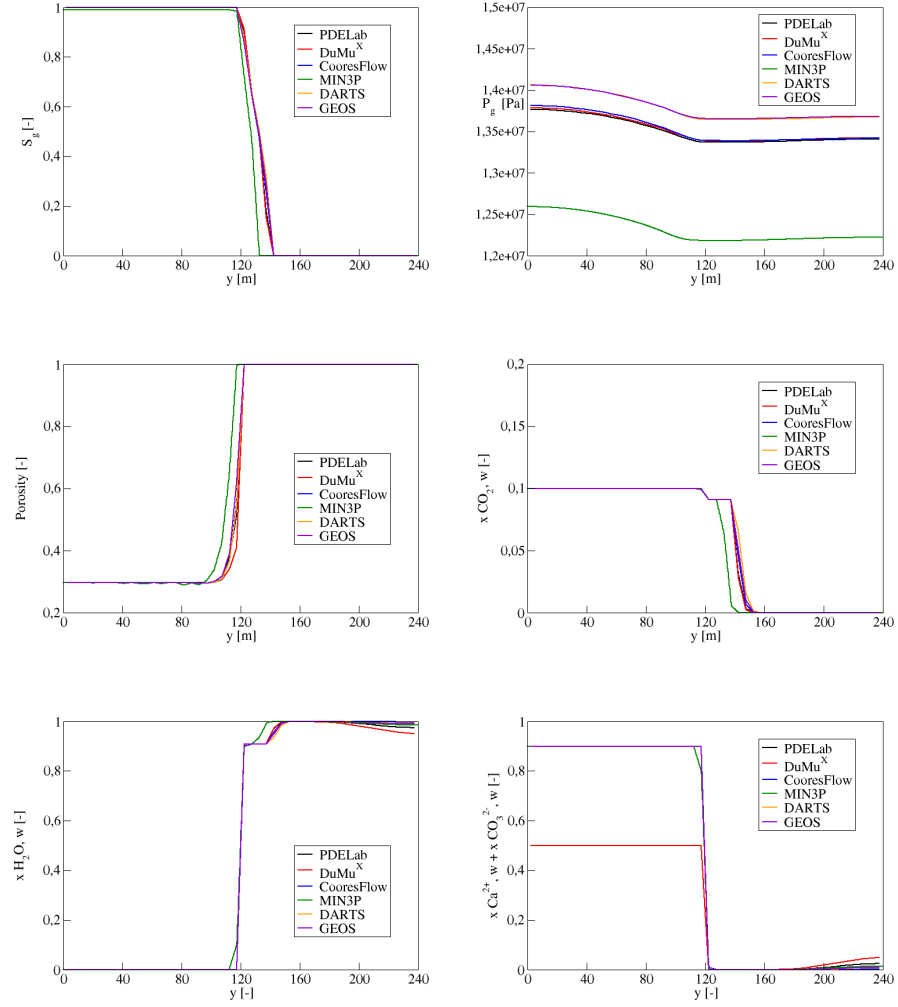


Figure 9: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $\text{CO}_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $t = 1000$  days on vertical line  $x = 40$  m for Test 2.1 without gravity.

### 3.3 Horizontal line at $y = 50$ m for the Test 2.1 without gravity

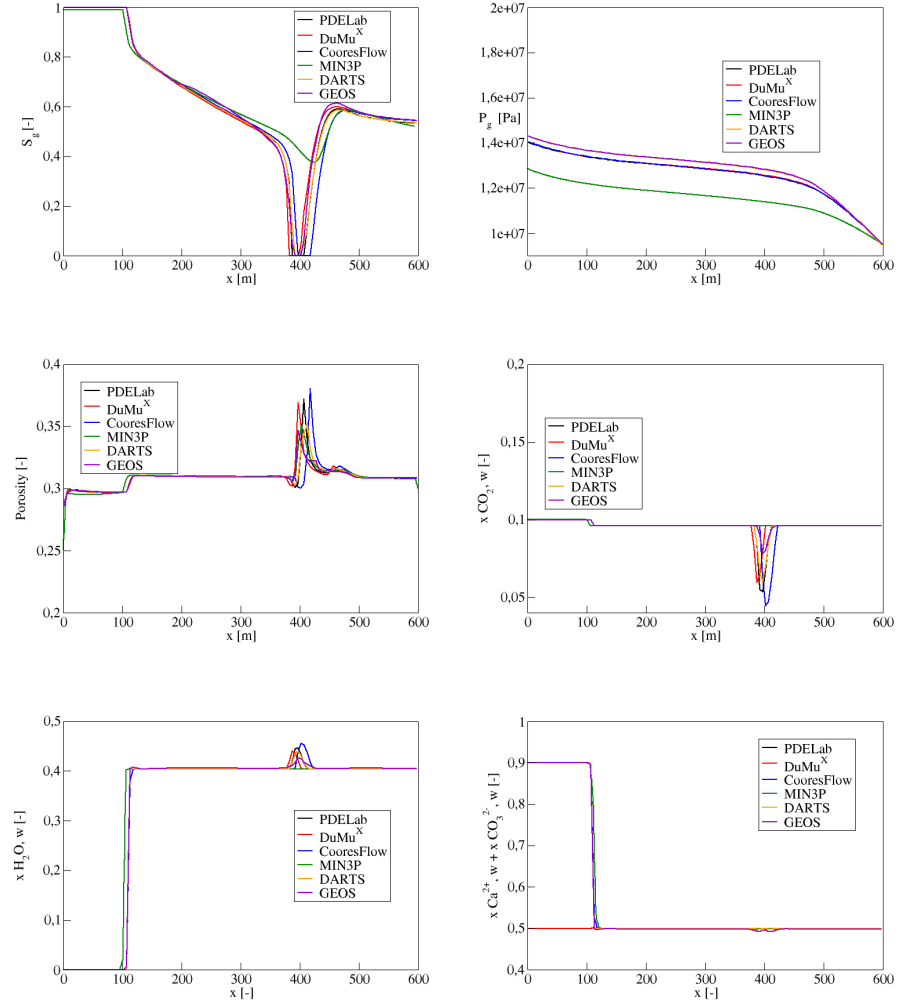


Figure 10: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $\text{CO}_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $t = 1000$  days on the horizontal line  $y = 50$  m for Test 2.1 without gravity.

## 4 Test 2.1 : 2D with gravity

### 4.1 Contour maps for the Test 2.1 with gravity

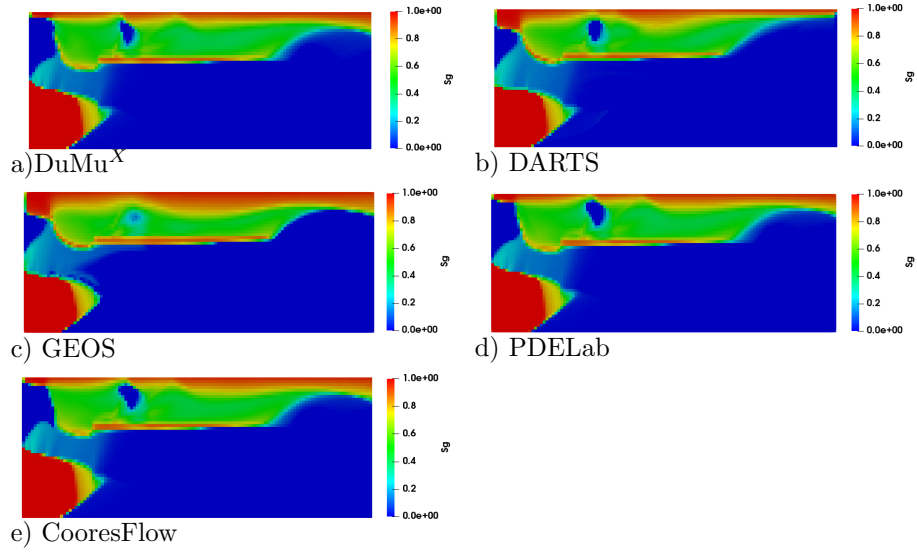


Figure 11: Comparison of gas saturation  $S_g$  at  $t = 1000$  days for the 2D test with simple chemistry and with gravity.

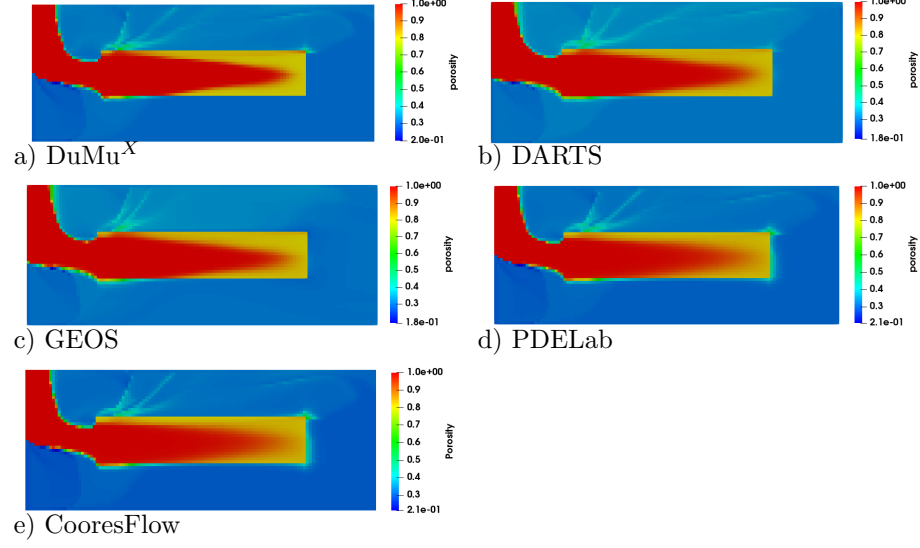


Figure 12: Comparison of porosity  $\phi$  at  $t = 1000$  days for the Test 2.1 with gravity.

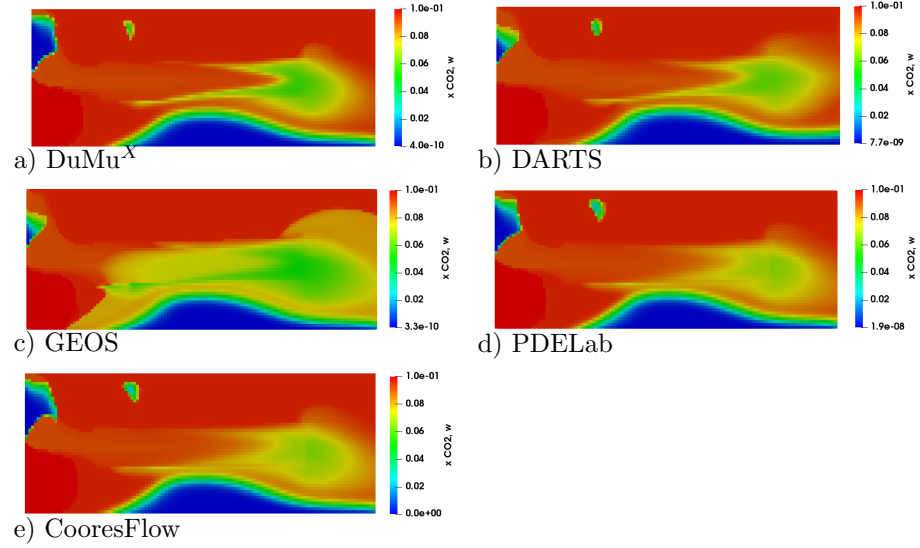


Figure 13: Comparison of liquid  $\text{CO}_2$  fraction  $x_{\text{CO}_2, w}$  at  $t = 1000$  days for the Test 2.1 with gravity.

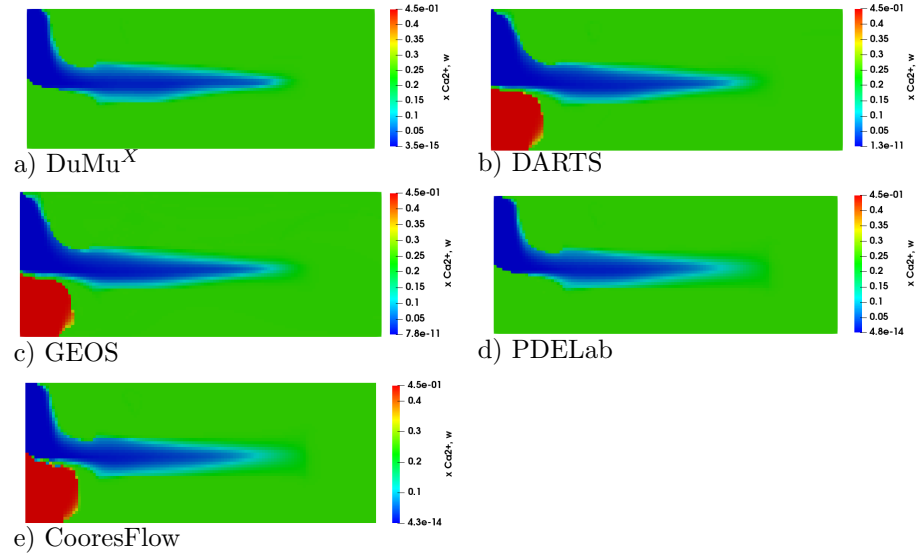


Figure 14: Comparison of liquid  $\text{Ca}^{2+}$  fraction  $x_{\text{Ca}^{2+},w}$  at  $t = 1000$  days for the Test 2.1 with gravity.

## 4.2 Vertical line at $x = 40$ m for the Test 2.1 with gravity

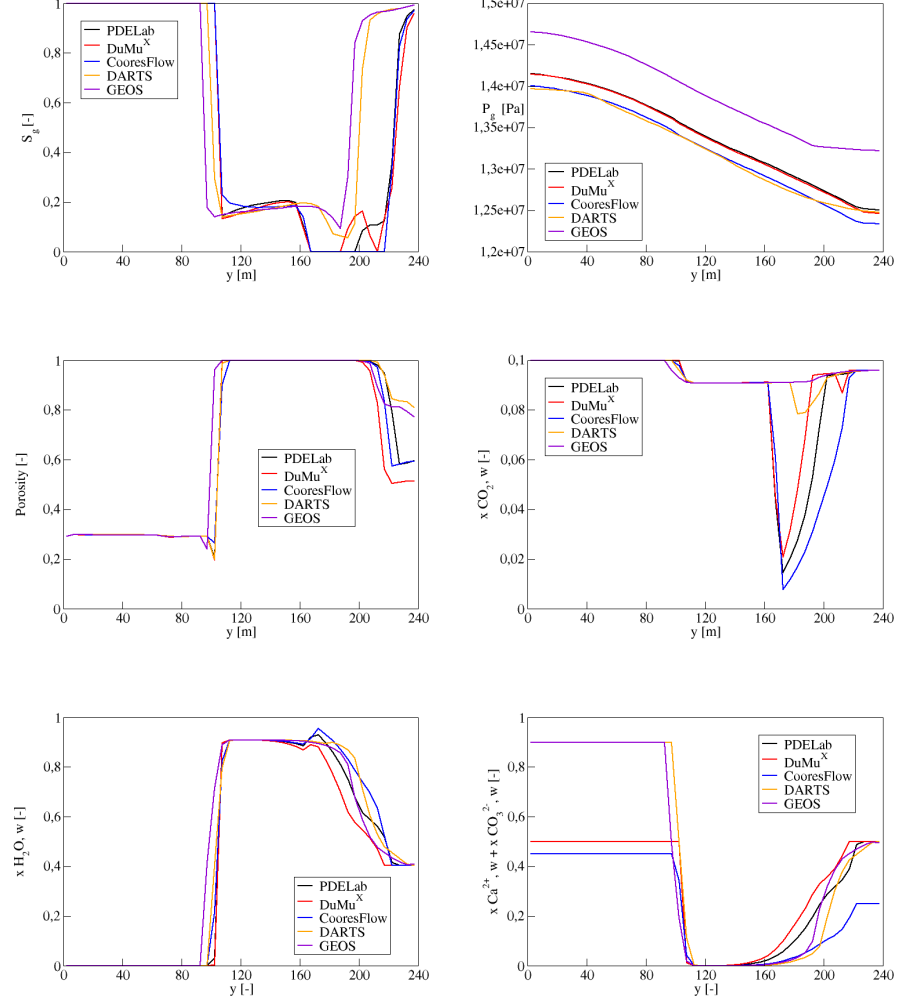


Figure 15: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $\text{CO}_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $t = 1000$  days on vertical line  $x = 40$  m for Test 2.1 with gravity.

### 4.3 Horizontal line at $y = 50$ m for the Test 2.1 with gravity

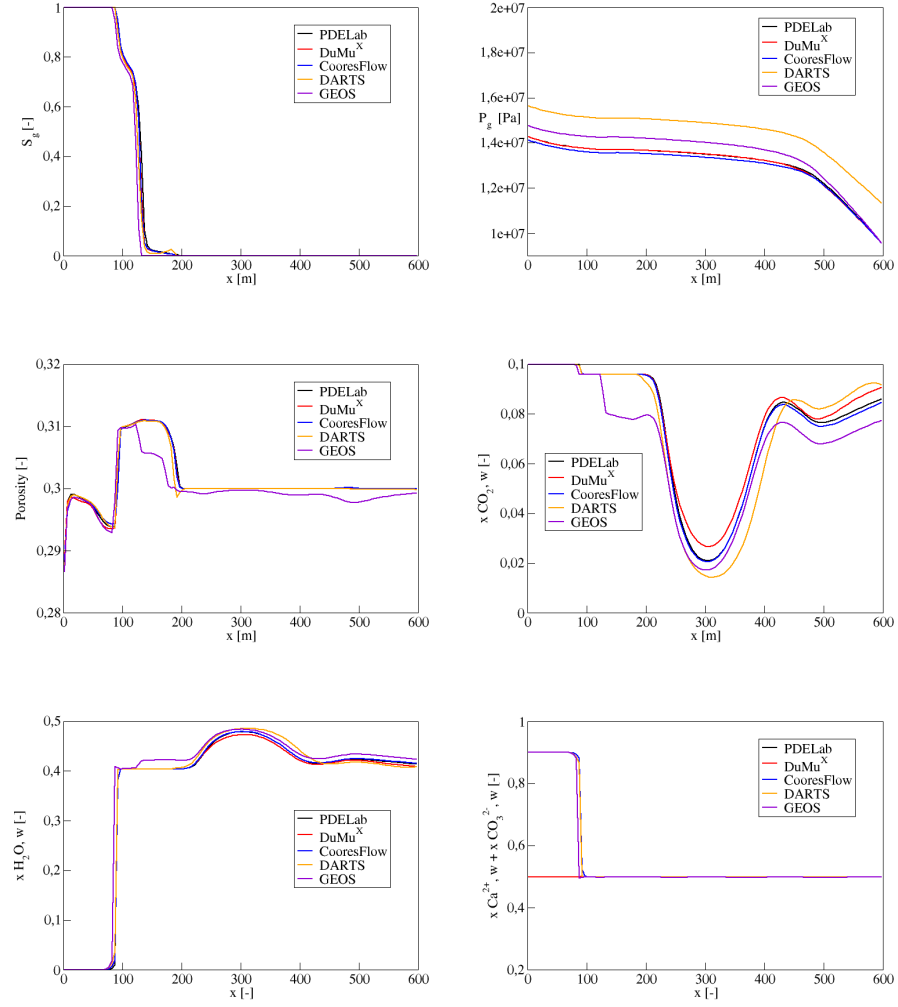


Figure 16: Comparison of gas saturation (top left), gas pressure (top right), porosity (middle left), liquid  $\text{CO}_2$  fraction (middle right), liquid water fraction (bottom left), liquid total ion fraction (bottom right) at  $t = 1000$  days on vertical line  $y = 50$  m for Test 2.1 with gravity.

## 5 Test 2.2: 2D extended chemical system

### 5.1 Contour maps for Test 2.2

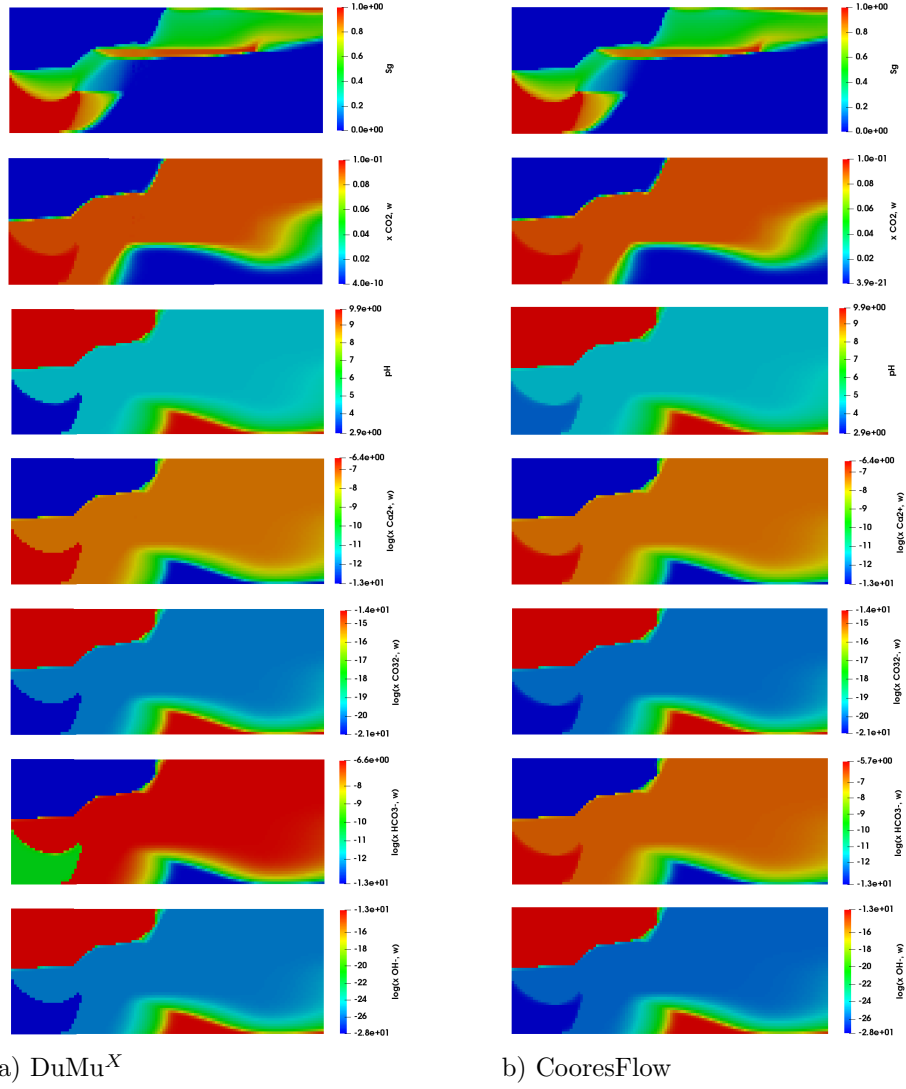


Figure 17: Comparison of several quantities at  $t = 1000$  days for the Test 2.2 (left column: DuMuX, right column: CooresFlow). From top to bottom: gas saturation, liquid  $\text{CO}_2$  fraction, pH, logarithm of liquid  $\text{Ca}^{2+}$  fraction, logarithm of  $\text{CO}_3^{2-}$ , logarithm of liquid  $\text{HCO}_3^-$  fraction, logarithm of  $\text{OH}^-$



## 5.2 Vertical line at $x = 40$ m for the Test 2.2

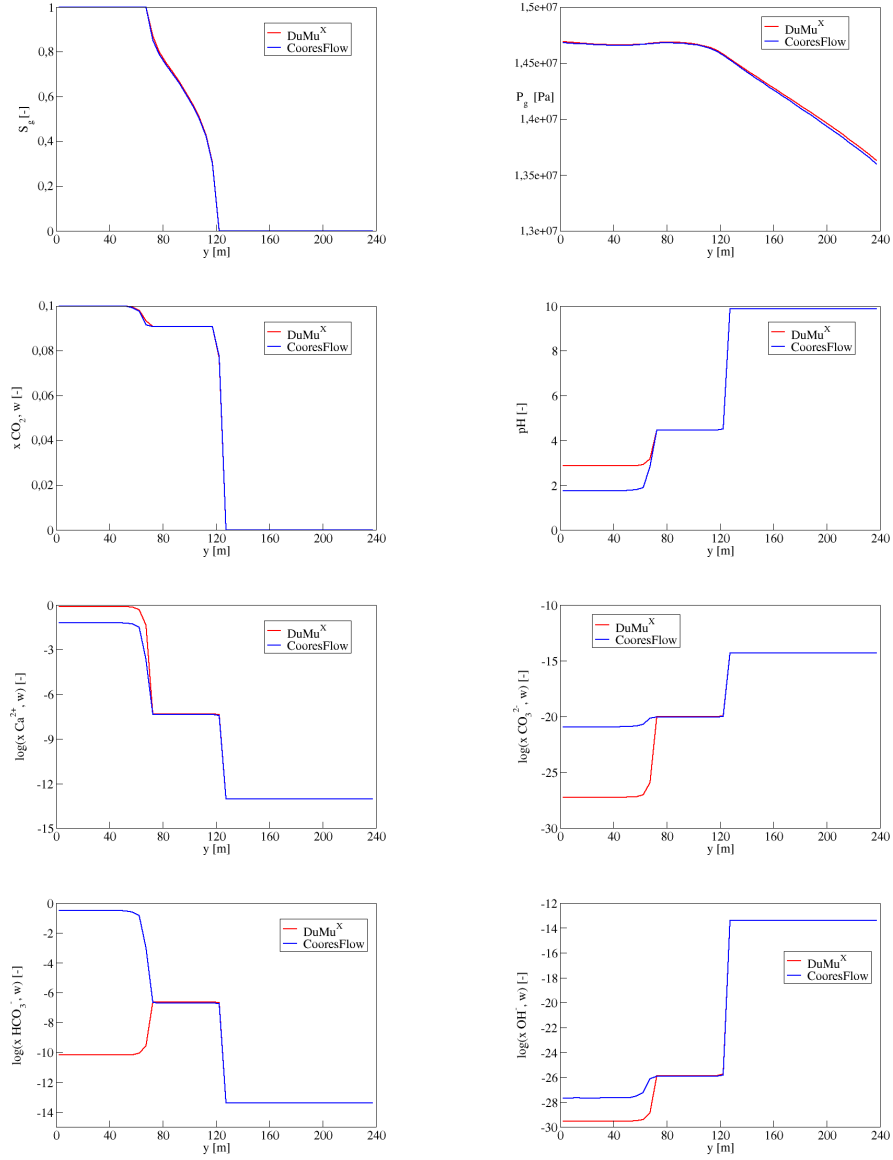


Figure 18: Comparison of gas saturation (top left), gas pressure (top right), liquid  $\text{CO}_2$  fraction (second row left), pH (second row right), logarithm of liquid  $\text{Ca}^{2+}$  fraction (third row left), logarithm of liquid  $\text{CO}_3^{2-}$  fraction (third row right), logarithm of  $\text{HCO}_3^-$  (bottom left), logarithm of  $\text{OH}^-$  (bottom right) at  $t = 1000$  days on vertical line  $x = 40$  m for Test 2.2.

### 5.3 Horizontal line at $y = 50$ m for the Test 2.2

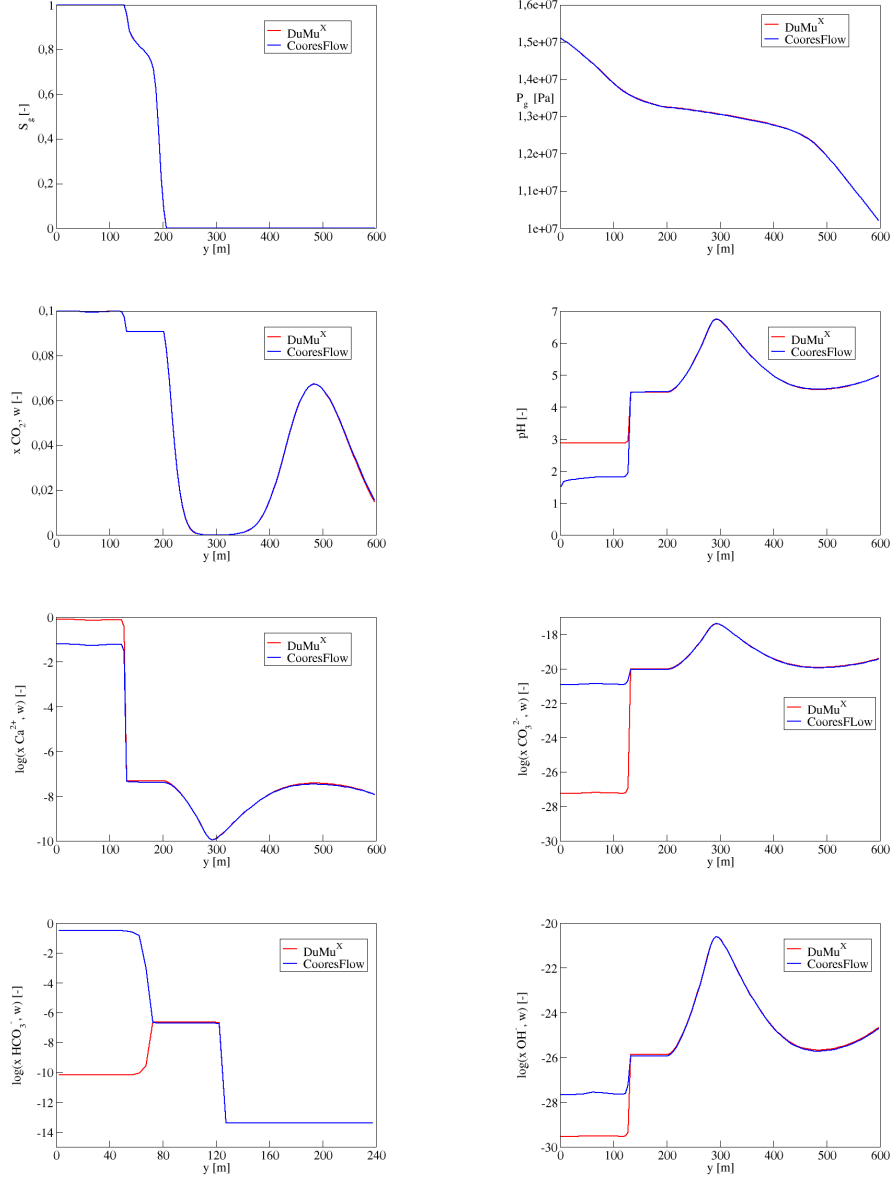


Figure 19: Comparison of gas saturation (top left), gas pressure (top right), liquid  $\text{CO}_2$  fraction (second row left), pH (second row right), logarithm of liquid  $\text{Ca}^{2+}$  fraction (third row left), logarithm of liquid  $\text{CO}_3^{2-}$  fraction (third row right), logarithm of  $\text{HCO}_3^-$  (bottom left), logarithm of  $\text{OH}^-$  (bottom right) at  $t = 1000$  days on vertical line  $y = 50$  m for the Test 2.2.